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THE INNOVATION PARADOX: STARTING FROM WHAT IS 'KNOWN' TO FACILITATE THE DISCOVERY OF THE 'UNKNOWN'

Karel Vandenhende
KU Leuven, Belgium

ABSTRACT
How can we teach students to design creatively? From the literature on early stages in effective learning processes, we know that for education to be effective, design assignments should evolve from easy to difficult, from simple to complex, from small-scale to larger, and also from what is known to the unknown. Applying this principle 'starting from what is known' to 'learning how to discover the unknown', causes a paradox.
Our investigation of this paradox with regard to typical aspects of the design process, seems to confirm this teaching principle. Designing is an iterative process in which the cycle of concept, test, evaluation and conclusion is repeated until a satisfactory solution has been formulated. Starting from what is known can help students enter that cycle. If students are offered a first solution they can immediately start transforming and adjusting, and thus can bypass the frightening blank page.
This theoretical framework, based on literature, was tested in a specific case. In this assignment, students started from what was known to them, and their design process immediately took off and seamlessly evolved into the discovery of the unknown.

Keywords: creativity, known, unknown, design process, transform.

1 PROLOGUE

1.1 Introduction and motivation
Design education students of today are the designers of tomorrow. In the future, they will continue to optimise existing objects and processes, as we are doing today. Apart from substituting existing designing processes and objects by new ones, they will also face completely new challenges, as we do now. For both of these challenges , and because users of objects, buildings and processes will also need design, not to only comfort them, but also to startle [1] and astonish them [2], future designers will have to be able to invent new solutions and designs. Hence in design education, one of the aspects that we have to teach students is to design the unknown, the new. In other words, we have to teach them to design creatively. How can we teach them to incorporate creativity in their design process? How can we facilitate the discovery of the unknown?

1.2 Approach
We will begin this paper with a literature review of previous research on effective learning processes. Previous research shows that 'starting from what is known' is one of the aspects of powerful learning environments. Applying this principle to 'learning how to discover what is yet unknown' results in a paradox. Furthermore, if we then confront this principle with typical aspects of the design process, the paradox will be confirmed. Moreover, starting from what already exists, seems to facilitate cultural continuity as an important design quality. Finally, we will report on a specific case: a design assignment for first-year students in architectural design.

2 FROM EFFECTIVE LEARNING TO LEARNING DESIGNING SKILLS

2.1 Effective learning environments
Collins, Brown and Newman [3] have created a framework for designing powerful learning environments, in which students learn effectively. They distinguish four important aspects in the learning process: content, teaching methods, social context of the learning process, and sequence of

learning tasks. Concerning this last aspect, learning tasks should be ordered according to increasing complexity and diversity, in such a way that the result following the learning process requires increasing domain-specific knowledge and diversity of metacognitive skills. To be challenging, design assignments should be difficult enough, but not too difficult. Walburg [4] confirms this by stating that when challenges exceed skills, this will cause turmoil and anxiety, and when skills exceed challenges, students will become too relaxed and bored. Stuyck [5] suggests breaking up learning tasks into bite-sized chunks. Put differently, learning processes should set intermediary goals [6].

2.2 Effective learning applied to 'teaching how to discover the unknown'

Assignments should therefore evolve from easy to difficult, from simple to complex, from small-scale to larger, and also from the known to the unknown. For example, students should learn to draw a one-point perspective before trying to learn a more complex two-point perspective. They should start by adding an object on a perspectival photo with known vanishing point and known horizon and then proceed to learn all aspects of perspective drawing. As to teaching 'how to discover the new', the learning process might be facilitated by starting with assignments in which only minor aspects of an existing situation need to be changed. This type of assignments can then be followed by tasks involving larger revisions, and finally lead to assignments requiring new designs. This gradual process thus includes the paradox that the discovery of the unknown is facilitated by starting from what is known. We can call this the innovation paradox.

2.3 Confronting the innovation paradox with aspects of the design process

The design process as a cycle

Does the design process too include this paradox? Let us first investigate the characteristics of designing. During a design process, designers develop concepts. Concepts are the tentative solutions to one or more constraints of the problem at hand. Designers start by developing an initial solution. Unless the design proves completely successful, as Lawson [7] formulates it, one of two things happens to halt this evolutionary phase. Either the general form of the solution reveals itself incapable of solving enough problems, or so many modifications need to be made that the idea behind the solution is lost and abandoned. In either case, the designer is likely to choose the revolutionary step of starting a completely new train of thought.

The importance of generating variations or alternatives cannot be overestimated. According to Marples [8], the nature of the problem can only be found by examining it through proposed solutions, and it seems likely that its examination through just one proposal leads to a very biased view. It seems probable that at least two radically different solutions need to be attempted in order to obtain a clear picture of the 'real nature' of the problem through comparisons of subproblems.

More recently, Nigel Cross [9] has confirmed that designers seem reluctant to abandon early concepts, and to generate a wide range of alternatives. Although designers first and foremost need to solve a design problem, it may be beneficial to consider several solution concepts in the process. Such a multiple-solution approach should promote a more comprehensive assessment and understanding of the problem. Or as Heylighen [10] puts it; "the ill-defined nature of a design problem appears to necessitate the generation of alternatives to explore and understand its full complexity". According to Lawson [7], it is therefore perhaps better for designers to use divergent thinking in excess rather than too sparingly. For most people it is easier to think convergently than divergently on demand. Indeed, reason is more easily controlled than imagination and the results of free imaginative thought can readily be subjected to rational evaluation later.

Designing is thus an iterative process in which the cycle of concept, test, evaluation and conclusion is repeated until a satisfactory solution has been formulated. Designers start by developing a first solution, then evaluate that idea in drawings, models or other media and thereafter react to that evaluation by changing their solution or by developing a new one. This in turn is followed by another cycle of evaluation, and the formulation of other variations and so on. Once in the cycle, students are led by the rhythm of the process.

Starting from to avoid the frightening blank page

The cycle of design is evidently beneficial. The question now remains how students can be stimulated to enter this cycle. The formulation of a first solution often seems to be a difficult step to take. Mau [11] suggests starting anywhere, and Frederick [12] prompts students to do just about anything. "When a design problem is so overwhelming as to be nearly paralysing, don't wait for clarity to arrive before

beginning to draw. Drawing is not simply a way of depicting a design solution; it is itself a way of learning about the problem you are trying to solve".
Here an existing starting point can help bypass the frightening blank page, in that it immediately offers a first solution that students can analyse. By starting from an existing - perhaps minor - solution, students can immediately begin with what is already there, with what is already 'known'. They can take off with an experience and evaluation of something that exists, and react to that to explore the unknown, to explore alternatives. They immediately have a project that they can begin to manipulate and transform.
De Bono calls this reactive thinking [13]. It is easier to react than to be proactive. To take an example from everyday life: it is easier to evaluate a dinner in a restaurant than to invent a menu yourself. Herzog [14] compares this approach to the strategy of an aikido master who turns the attacker's energies to his own ends. By means of this tactic, something new is produced.

2.4 Cultural Continuity: what is known functions as a reference point and puts the new and unknown in perspective

Besides helping students start their design process in a natural and manageable way, teaching them to begin from a known and existing object or process also immediately incorporates a reference in the project. De Vylder [15] states that an architect should not always invent completely new concepts, but can start from an existing situation and bring that up to date. This will have the advantage of carrying the old in it. Part of the quality of the new lies in its comparison with the old. Or, as Perec [16] formulates this for art paintings: "A considerable number of, if not all, paintings only acquire their true significance in relation to the earlier works that are found in them, either simply reproduced whole or in part, or in a much more allusive manner, encrypted". Similarly, Geers [17] states for architecture: "The architect's project deals indirectly with everything that has happened before, both in the field of architecture and in the world. Architecture without acknowledging history is impossible. The project is not about inventions in order to bring something new into existence, but about formulating intentions to reassemble things already known in another way. In today's world, too much emphasis is put on the new, the fresh and the frenzy. Architecture is neither new nor old, architecture is always contemporary. Every new architecture reassembles chosen elements of a found reality."
Starting from the existing to invent the new will thereby automatically facilitate cultural continuity. According to Caruso [18], we are now working in a time that conspires to undervalue and dull our sensitivity to what has come before. Or as Ortega y Gasset is quoted in Rowe's Collage City [19]: "We cannot start afresh; that we must make use of what people have done before us. If we want to make progress, and this means that we must stand on the shoulders of our predecessors. We must carry on a certain tradition".

3 CASE

1.1 Introduction and approach

This theoretical framework, based on literature, was tested in a specific case. More particularly, for their first assignment in architectural education we asked architecture students to design a 'Time-out' as a complementary room to a student residence. This kind of 'Time-out' does not exist yet. It is a building type yet to be invented. However, once realised, it will provide room for activities, hobbies and distraction which are not possible in a standard study room. The room can be let to students on a daily basis. In each city, several of these Time-outs will be built, each with their own specific character.

1.2 Day 1 and 2: Exploring quantities

Before starting to design the Time-out itself, we asked the students specifically to start the assignment with an analysis of their own study room's quantities. On the first day, their existing room was measured up and drawn in plan and section. As a result, on the second day, students immediately had plans that they could use to transform, to explore alternative uses, dimensions and activities, to discover new possibilities. Several possible ways of provoking transformations were presented to the students as possible strategies: reversal, exaggeration, distortion, wishful thinking [20], as well as multiple procedures by which creative design might occur [21]: combination, mutation, analogy, first principles and emergence. [Figure 1]

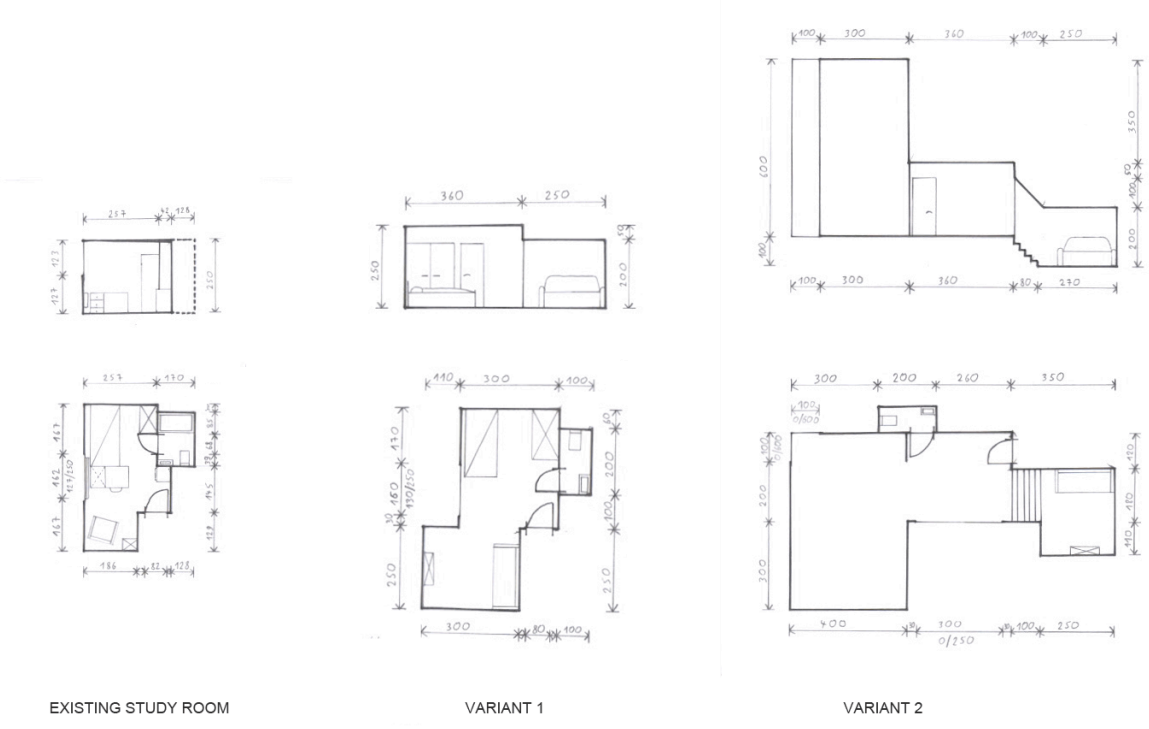

Figure 1. Plan and section of own study room, and two variants with optimized spaces by student DC.

1.3 Day 3, 4 and 5: Exploring qualities

After the first two days, we again asked students to start with an analysis of their own study room. This time they investigated the qualities of it in a clay model, and subsequently used it as a starting point to explore new architectural qualities. These were provoked by transforming several spatial characteristics: daylight, scale, proportions, and others. [Figure 2] Afterwards, research of the first five days was combined and further elaborated during the following weeks in a proposal for a 'Time-out'. [Figure 3]

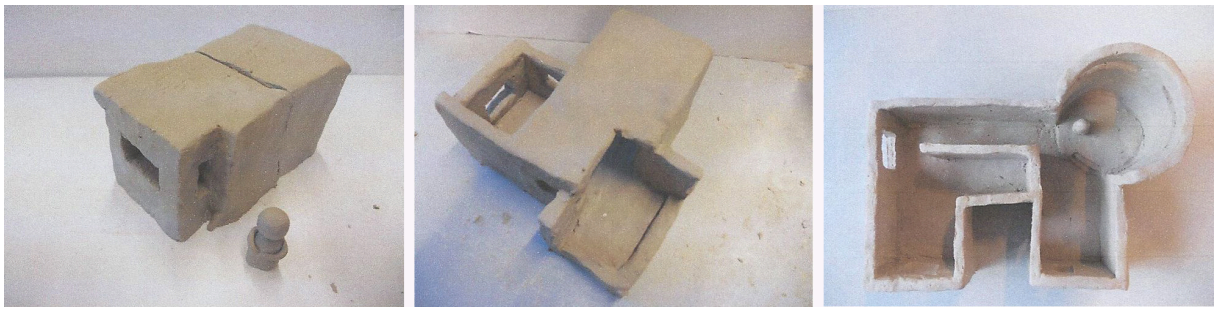

Figure 2. Model in clay of own study room (left), and two variants (middle and right), by student LB. The variants were developed simply by transforming qualities like for example room dimensions or quantity of windows in the clay model of the 'known' own study room.

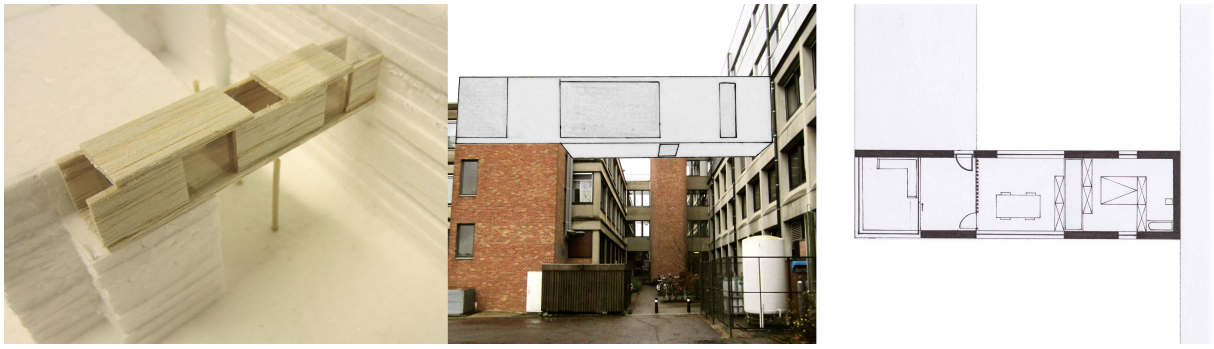

Figure 3. Elaborated design for a Time-out by student JM.

1.4 Evaluation

The results of the tasks this year were compared with the results of previous years. Students then also designed a Time-out, and were asked to explore quantities and qualities during the first five days. We then also presented them possible ways of provoking transformations and multiple procedures by which creative design might occur, but there was no working method imposed that started from a 'known' space. In previous years, students had to come up themselves with a first proposal that could be transformed in order to develop an interesting solution.

As a strategy for evaluation of the new design method that starts from the 'known', we organised an intermediate review after the fifth day, just as we did the previous years. This made it possible to compare the results before and after implementing the new working method.

What were the results? This year, after five days, each student had several possible variants, deliberately drawn and modelled, and correctly scaled. [Figure 1 and 2] One or more of these variants were interesting enough to be developed and elaborated during the following weeks. [Figure 3] On the other hand, in previous years, almost all students were still hesitating after five days to fully draw or model a first possible idea. And they were still struggling with dimensions and scale. [Figure 4] The differences in what most of the students could accomplish in a given timeframe were spectacular.

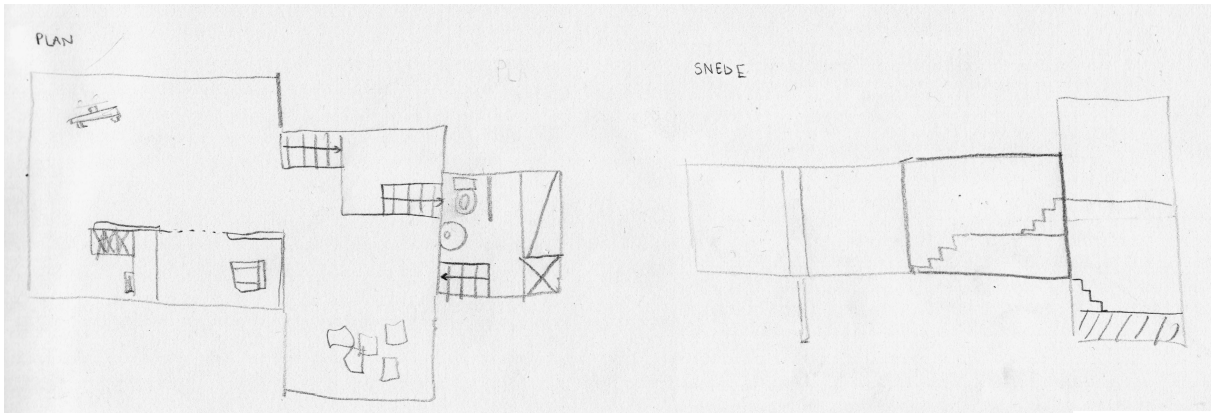

Figure 4. Result of a year ago, by student KV, when there was no working method that started from a 'known' space.

Apparently, the formulation of a first solution does indeed seem to be often a difficult step to take. Starting from an existing 'known' solution can overcome this problem, probably because students immediately can start drawing or modelling. From the beginning of the assignment, they have very clear tasks that they can accomplish, whereafter the work rhythm fluently continues in the generation of new spaces which they can create simply by transforming the existing situation they have drawn before, or by simply adjusting the model of the existing room they have previously modelled.

4 CONCLUSION

Having started from an existing room helped students initiate their design process in a natural and easy way. Although they started from what was known to them, their design process immediately took off and seamlessly evolved into the discovery of the unknown.

The advantage of being able to start with something that is already there, can also be illustrated by Johnson's [22] reference to the famous moment in the story of the near-catastrophic Apollo 13 mission

- wonderfully captured in the Ron Howard film - where the mission control engineers realise they need to create an improvised carbon dioxide filter ... . In the movie, Deke Slayton, head of Flight Crew Operations, tosses a jumbled pile of gear on a conference table: suit hoses, canisters, stowage bags, duct tape, and other assorted gadgets. He holds up the carbon scrubbers. "We gotta find a way to make this fit into a hole for this," he says, and then points to the spare parts on the table, "using nothing but that."

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